Europäisches Patentamt
European Patent Office
Office européen des brevets

Bescheinigung Certificate Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

02079079.6

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Anmeldung Nr:
Application no.: 02079079.6
Demande no:

Anmeldetag:
Date of filing: 03.10.02
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

Storage system using electromagnetic array

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

G11B5/00

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR

Storage system using electromagnetic array

The invention relates to a storage system comprising a record carrier and a storage device, the record carrier having an information plane that is provided with an electro-magnetic material constituting an array of bit locations, a magnetic state of said material at a bit location representing the value thereof.

The invention further relates to a record carrier comprising an information plane on a substrate that is provided with a layer of an electro-magnetic material constituting an array of bit locations, a magnetic state of said material at a bit location representing the value thereof.

The invention further relates to a storage device.

A storage system, record carrier, and a device for storing information are known from patent US 5,956,216. Data storage systems using magnetic material on a disc-type record carrier are well known, for example a removable type magnetic record carrier like the floppy disk. The document describes a magnetic record carrier of a patterned type. The record carrier has an information plane that is provided with a magnetic layer that can be magnetized by a suitable magnetic field from a write head. In particular the information plane is provided with a non-magnetic substrate and magnetic domain elements that can have two magnetization values. The magnetic domain elements constitute bit locations for storing a single bit of data. The device has a head and a write unit for recording information in a track constituted by the bit locations on the record carrier. The value of a bit location must be set or retrieved by positioning a read/write head opposite the bit location, e.g. by scanning the track. A problem of the known magnetic storage system is that the scanning does not allow immediate random access to any bit location. The process of positioning the head via a jump to a required part of the track is time consuming.

Therefore it is an object of the invention to provide a system comprising a record carrier and a device for storing information that allows fast access to the bit locations.

According to a first aspect of the invention the object is achieved with a storage system as defined in the opening paragraph, the storage device having an interface surface for cooperating with the information plane, which interface surface is provided with an array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material, which record carrier can be coupled to and removed from the storage device, and which system has alignment means for positioning the bit locations near the electro-magnetic elements within a near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling.

According to a second aspect of the invention the object is achieved with a record carrier as defined in the opening paragraph, characterized in that the record carrier comprises alignment means for positioning the bit locations near the electro-magnetic elements within a near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling.

According to a third aspect of the invention the object is achieved with a device as defined in the opening paragraph, characterized in that the device comprises an interface surface for cooperating with the information plane, which interface surface is provided with an array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material, and alignment means for positioning the electro-magnetic elements near the bit locations within a near-field working distance between an electro-magnetic element and the corresponding bit location during said coupling.

The effect of the array constituted by electro-magnetic elements cooperating with the information plane is that data from a large number of bit locations can be retrieved simultaneously via electro-magnetic interaction. This has the advantage that data can be accessed at a high speed. In particular the alignment is different from a scanning system in that the array is aligned to the bit locations parallel to the information plane and also in height with respect to the information plane. Compared to scanning magnetic hard-disk systems the advantage is that no high scanning speed between a head and the disk is needed, which prevents fatal head-disk interactions like a head-crash.

The invention is also based on the following recognition. The magnetic hard-disk storage system provides a non-removable record carrier that can be recorded by magnetizing material in a layer or pattern in a user device. However removable magnetic discs like floppy discs are slow and large, and require a scanning mechanism which is sensitive to mechanical shocks. The inventors have seen that data on a record carrier can be accessed fast and reliably by bringing the surface of the information plane into close vicinity

of an array of electro-magnetic elements. The elements can detect a magnetic state within a predefined near-field working distance, which is in practice in the same order of magnitude as the minimum dimensions of the bit location. Alignment is required to bring the elements opposite and close to the bit locations within the near-field working distance. Suitable read/write elements can be produced using solid state production methods, e.g. known from producing MRAM magnetic storage devices.

In an embodiment of the record carrier the substrate is of a flexible material for allowing positioning of the bit locations near the electro-magnetic elements within the near-field working distance between a bit location and the corresponding electro-magnetic element. A rigid substrate requires a highly level plane. The flexible material has the advantage that close contact between the bit locations and the electro-magnetic elements is easily achieved by applying pressure on the flexible material.

Further preferred embodiments of the record carrier and storage device according to the invention are given in the further claims.

These and other aspects of the invention will be apparent from and elucidated further with reference to the embodiments described by way of example in the following description and with reference to the accompanying drawings, in which

Figure 1 shows an information carrier part (top view),

Figure 2 shows an information carrier part and electro-magnetic elements,

Figure 3 shows a read-out part,

Figure 4a shows a storage device (top view) and record carrier,

Figure 4b shows a storage device (side view) and record carrier,

Figure 4c shows a record carrier in a cartridge,

Figure 5 shows an array of electro-magnetic elements,

Figure 6 shows a sensor element in read mode, and

Figure 7 shows a read/write element in write mode.

In the Figures, elements which correspond to elements already described have the same reference numerals.

Figure 1 shows an information carrier part (top view). An information carrier part 10 has an information plane that is provided with a magnetic material 12 constituting an

array of bit locations 11. The magnetic state of the material 12 at the information plane provides a physical parameter for representing a value of a bit location. It is noted that the information plane is situated on a top surface 13 of the information carrier part 10. The top surface 13 of the information carrier part is intended to be coupled to an interface surface of a read-out part. The information plane is considered to be present at an effective distance from the mechanical top layer, e.g. a thin cover layer for protecting the information plane may constitute the outer layer of the information carrier part. Further it is noted that material away from the top surface 13 and outside a near-field working distance of an intended read-out part is not considered part of the information plane. Electro-magnetic elements in said read-out part are placed near the information plane, but some intermediate material like contamination may be present in between. Hence the effective distance is determined by any intermediate material. The intended read-out elements that have a near-field working distance extending outward from the interface surface towards the information plane. The physical effect of the magnetic state of material at the information plane for reading the information is explained below with reference to Figure 2.

Figure 2 shows an information carrier part and electro-magnetic elements. The information carrier part is constituted by a substrate 21. An information plane is constituted on the top side of the substrate 21 by a layer 22 of magnetic material, areas of the information layer constituting an array of bit locations 23. In a first bit location opposite a first electro-magnetic element 24 the material has a magnetic state for example indicating the logic value 1, in a second bit location opposite a second electro-magnetic element 25 the material has a magnetic state indicating a logic value 0, and in a third bit location opposite a third electro-magnetic element 26 the material has a magnetic state indicating a logic value 1. The electro-magnetic elements 24,25,26 have a multilayer stack for detecting the magnetic state as described in detail with Figure 6. The top layer of the multilayer stack is influenced by the magnetic state of the bit location. The layer 23 of magnetic material can be applied by well known manufacturing methods for magnetic media, and programming may be applied during production for presetting the magnetic states of the bit locations. Suitable manufacturing methods are sputtering or pressing using a mask.

Figure 3 shows a read-out part. The read-out part 30 is intended to cooperate with the information carrier parts described above. Thereto the read-out part has an interface surface 32. The interface surface 32 is provided with an array 31 of electro-magnetic elements. The array is a two-dimensional layout of electro-magnetic sensor units that are

sensitive to the magnetic state of the material on a near-field working distance. The array is similar to solid state MRAM arrays of bit cells as described below with reference to Figure 5.

It is noted that other combinations of an electro-magnetic material and a sensor unit can be chosen. In another embodiment the sensor units are arranged for emitting light as the electromagnetic field for affecting the state of the material, e.g. phase-change material known from CD-RW, and detecting the effect of the material on a near-field working distance from the source of light. The further embodiments described below are based on using magnetic material. A suitable material is a hard magnetic material and a suitable electro-magnetic element is based on the magneto-resistive effect. An example is described below with reference to Figures 6 and 7.

Figure 4a shows a storage device (top view) and record carrier. The storage device has a housing 35 and an opening 36 for receiving a record carrier 40.

The record carrier 40 includes an information carrier part 10 that has an information plane that has an array of bit locations 11 as described above with reference to Figures 1 and 2. Further the record carrier has alignment elements 41 for cooperating with the complementary alignment elements 38 on the device for positioning the bit locations near the electro-magnetic elements within the near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling. Read-out of the record carrier is realized by providing appropriate alignment and registration during insertion of the medium in the reader device as described below. In an embodiment the alignment elements are predefined and precisely shaped parts of the outer walls of the information carrier part. It is noted that the record carrier can be substantially only the information carrier part as described above, or an assembly containing an information carrier part. For example a single substrate carrying the information plane is further shaped to accommodate the several types of alignment elements as described hereafter.

When coupling the record carrier 40 to the storage device 35 the record carrier is placed on the opening 36. The opening 36 is provided with an interface surface 32 on a read-out unit 30 as described above with reference to Figure 3, and with alignment elements 38, for example protruding pins. The alignment elements 38, 41 are arranged for determining the position of the bit locations on the record carrier with respect to the position of the interface surface of the read-out unit 30 in planar directions parallel to the interface surface.

In an embodiment the opening 36 is a recess in the surface of the housing, the recess having precisely shaped walls as alignment elements for cooperating with the outer perimeter of the record carrier 40 for aligning the information carrier part.

In an embodiment the storage device is provided with processing circuitry for analyzing the read-out signals of the electro-magnetic elements for eliminating influences of neighboring bit locations. Any electro-magnetic element may be influenced somewhat by adjacent bit locations, in particular due to some remaining misalignment. However, by analyzing the read-out signals of neighboring electro-magnetic elements and subtracting some of those from the current read-out signal, the detected value of the current bit location is improved. Hence electronic correction of inter-symbol interference is provided. The analysis may be controlled by global information about the remaining misalignment, for example indicating which of the neighboring read-out signals must be subtracted and to which extent.

In the direction perpendicular to the interface surface some pressure is required to make sure that the distance of the bit locations to the electro-magnetic elements in the read-out part is within the near-field working distance. The pressure may be provided by a user just pressing the record carrier to the storage device, or by a resilient lid or cover on top of the record carrier (not shown). Other options for achieving close physical contact are well-known to a skilled man.

In an embodiment of the record carrier the information plane is provided on a flexible substrate. The device is provided with a pressure system for bringing the flexible substrate in close contact with the interface surface, for example by creating a low pressure or vacuum between the substrate and the interface surface. In an embodiment the device is provided with a generator for generating an attracting field for attracting the information carrier to the interface surface. The type of attracting field is different from the field used by the sensor element. For example an electrostatic field is generated for attracting a record carrier of a magnetic type. Alternatively a magnetic field is generated for a record carrier based on capacitive read-out.

In an embodiment the alignment elements 38 on the device are connected to actuators for moving the record carrier with respect to the interface surface 32. Only a small movement, in the order of magnitude of the dimensions of a single bit location (i.e. a few μm), is sufficient to align the electro-magnetic elements with the bit locations. For the actuators several types may be used, e.g. voice coil type, piezo type or electrostatic type. In an embodiment the actuators are controlled by detecting misalignment of the bit locations. The misalignment can be derived from read-out signals of the electro-magnetic elements. For example if there is a substantial misalignment the electro-magnetic elements will cover adjacent bit locations. Read-out signals of adjacent locations having the same value will be

different from read-out signals of adjacent locations having differing values. Hence if such differences occur, i.e. if the read signals of some bit locations have values at an intermediate level between the maximum and minimum levels of other bit locations, misalignment is detected. It is noted that in non correlated data the intermediate levels will occur in substantially 50% of the bit locations due to the fact that the respective neighboring location has a same or different logical value. In an embodiment predefined control patterns having known neighboring bits are included for misalignment detection. A control signal is generated to activate the actuators, and after applying the control signal the read-out signal is again analyzed. In an embodiment the record carrier is provided with optical marks for alignment, and the device is provided with separate optical sensors for detecting the optical marks for generating a misalignment signal.

In an embodiment of the storage system the pitch of the array of electro-magnetic elements is larger than the pitch of the array of the bit locations, for example by an integral factor $n = 2$ in one or both planar dimensions. Some stepwise movement of the information carrier part relative to the read-out part is provided to read-out positions in each direction in which the pitch differs to access every bit location. The movement may be provided as indicated above, e.g. by the actuators. Such scanning over small distances by means of micro-mechanic means can make it possible to use media with a higher bit density than the density of the read-out part.

In an embodiment of the record carrier the information plane is provided with position mark patterns that are unique patterns in the information plane within a predefined area of the information carrier. The storage device is provided with a processor for applying techniques of pattern recognition for detection the absolute position of the position mark patterns with respect to the electro-magnetic elements array by analyzing the signals detected from the electro-magnetic elements. For example the position mark patterns may comprise a large area of material at a predefined magnetic state which is larger than any initial mechanical misalignment. The large area is surrounded by a contour with material having a different state in a predetermined pattern. Hence some electro-magnetic elements will always initially be covered by said large area. By analyzing the surrounding electro-magnetic elements the misalignment can be detected easily.

In an embodiment the array of electro-magnetic elements is substantially smaller than the information plane, e.g. 4 times smaller. The device is provided with actuators that are arranged for positioning the record carrier or the array of electro-magnetic elements at a few, e.g. 4, read-out positions for reading areas of the information plane.

In an embodiment the alignment elements of the record carrier are constituted by oblong protruding guiding bars, and the complementary guiding elements on the device are slots or grooves. The alignment by these elements is effective in one planar dimension. The alignment in the other planar dimension may be provided by a wall or protruding stopping pin on the device. Alternatively there may be no specific stopping position in the second planar dimension, but the information is retrieved from the bit locations while the record carrier is being propelled along that second direction, e.g. by the user pushing the record carrier via a guiding slot. Such constellation is advantageous for one-time reading of data from the record carrier, e.g. in an application like a personal passport carrying biomedical or DNA information for access control at an airport.

Figure 4b shows a storage device (side view) and record carrier. The storage device has a housing 45 and an opening 43 for receiving a record carrier 40. When coupling the record carrier 40 to the storage device 45 the record carrier is placed on the opening 43. Close contact between the two parts is obtained by pressing (possibly with contact liquid) the read-out array against the information carrier when the slot of the reader is closed. The opening 43 is provided with an interface surface 32 on a read-out unit 30 as described above with reference to Figure 3, and with alignment elements 42 at the inner end of the opening and outer alignment elements 44 at the entry side of the opening 43. The outer alignment elements 44 are arranged for clamping the record carrier. The record carrier has a protruding alignment element 41 for cooperating with the clamping outer alignment elements 44 on the device for positioning the bit locations near the electro-magnetic elements within the near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling. The clamping movement may be activated by the force the user applies during entering the record carrier into the opening, or by an actuator.

Figure 4c shows a record carrier in a cartridge. The record carrier has a cartridge 47 enclosing the information carrier part 10. The cartridge 47 has a movable cover 48 that effectively seals off the information plane from contamination (dust and fingerprints) when the record carrier is not coupled to a storage device. A storage device has an opening mechanism (not shown) for moving the cover aside during said coupling. Several options for slidable covers are known from optical or magnetical recording disc cartridges and cooperating devices.

In an embodiment the cartridge comprises a cleaning pad 46. The pad 46 is located on and/or moved by the cover 48 for wiping the information plane and/or the interface surface when the cover is moved. Alternatively the pad or other cleaning units such

as a brush may be placed on the cartridge itself. In an embodiment the cartridge is provided with a dust attracting inner layer for attracting any dust particles that may have entered the closed cartridge in spite of the cover 48.

Figure 5 shows an array of electro-magnetic elements. The array has electro-magnetic elements 51 in a regular pattern of rows. The elements of a row are coupled by shared bit lines 53, while in columns the elements share word lines 52. The electro-magnetic elements shown have a multilayer stack. An electro-magnetic element 54 is shown having opposite magnetic states in layers of the multilayer stack for representing the configuration when measuring a bit location with a logic value 0. An electro-magnetic element 55 is shown having equal magnetic states in layers of the multilayer stack for representing the configuration when measuring a bit location with a logic value 1. The direction is detected in sensor elements having a multilayer or single layer stack by using a magneto-resistive effect, for example GMR, AMR or TMR. The TMR type sensor is preferred for resistance matching reasons for the sensor element. While the given examples use magnetoresistive elements with in-plane sensitivity it is also possible to use elements that are sensitive to perpendicular fields. For a description of sensors using these effects refer to "Magnetoresistive sensors and memory" by K.-M.H. Lenssen, as published in "Frontiers of Multifunctional Nanosystems", page 431-452, ISBN 1-4020-0560-1 (HB) or 1-4020-0561-X (PB).

In the array electro-magnetic elements may be read-only elements only having the parts needed for read-mode as described with Figure 6 for constituting a playback-only device. This has the advantage that no electronic circuitry is needed for generating write currents. For example the device is a player for music which does not need a record function. Alternatively the electro-magnetic elements may be read-write elements as described with Figure 7. This has the advantage that the user may change the values of the bit locations. In an embodiment the array has a combination of read-only and read-write elements. This has the advantage that specific data on the record carrier is protected against accidental change and/or tampering with malicious intends. For example such data may be used for digital rights management, e.g. storing keys for copy protection by the content owner.

In the storage system data are represented by magnetization directions occurring at a sensor element due to the bit location opposite the sensor on the information plane. In the sensor element the read-out is done by a resistance measurement which relies on a magnetoresistance (MR) phenomenon detected in a multilayer stack. Sensor elements can be based on the anisotropic magnetoresistance (AMR) effect in thin films. Since the amplitude of the AMR effect in thin films is typically less than 3%, the use of AMR requires

sensitive electronics. The larger giant magnetoresistance effect (GMR) has a larger MR effect (5 à 15%), and therefore a higher output signal. The magnetic tunnel junctions use a large tunnel magnetoresistance (TMR) effect, and resistance changes up to ≈50% have been shown. Because of the strong dependence of the TMR effect on the bias voltage, the useable resistance change in practical applications is at present around 35%. In general, both GMR and TMR result in a low resistance if the magnetization directions in the multilayer stack are parallel and in a high resistance when the magnetizations are oriented antiparallel. In TMR multilayers the sense current has to be applied perpendicular to the layer planes (CPP) because the electrons have to tunnel through the barrier layer; in GMR devices the sense current usually flows in the plane of the layers (CIP), although a CPP configuration might provide a larger MR effect, but the resistance perpendicular to the planes of these all-metallic multilayers is very small. Nevertheless, using further miniaturization, sensors based on CPP and GMR are possible.

Figure 6 shows a sensor element in read mode. The sensor element has a bit line 61 of an electrically conductive material for guiding a read current 67 to a multilayer stack of layers of a free magnetic layer 62, a tunneling barrier 63, and a fixed magnetic layer 64. The stack is build on a further conductor 65 connected via a selection line 68 to a selection transistor 66. The selection transistor 66 couples said read current 67 to ground level for reading the respective bit cell when activated by a control voltage on its gate. The magnetization directions 69 present in the fixed magnetic layer 64 and the free magnetic layer 62 determine the resistance in the tunneling barrier 63, similar to the bit cell elements in an MRAM memory. The magnetization in the free magnetic layer is determined by the magnetic state of the material of the bit location opposite the sensor element as described above with Figure 2, when such material is within the near-field working distance indicated by arrow 60.

In an embodiment a number of sensor elements are read at the same time. The addressing of the bit cells is done by means of an array of crossing lines. The read-out method depends on the type of sensor. In the case of pseudo-spin valves a number of cells (N) can be connected in series in the word line, because the resistance of these completely metallic cells is relatively low. This provides the interesting advantage that only one switching element (usually a transistor) is needed per N cells. The associated disadvantage is that the relative resistance change is divided by N. The read-out is done by measuring the resistance of a word line (with the series of cells), while subsequently a small positive plus negative current pulse is applied to the desired bit line. The accompanying magnetic field

pulses are between the switching fields of the two ferromagnetic layers; thus the layer with the higher switching field (the sensing layer) will remain unchanged, while the magnetization of the other layer will be set in a defined direction and then be reversed. From the sign of the resulting resistance change in the word line it can be seen whether a '0' or a '1' is stored in the cell at the crossing point the word and the bit line. In an embodiment spin valves with a fixed magnetization direction are used and the data is detected in the other, free magnetic layer. In this case the absolute resistance of the cell is measured. In an embodiment the resistance is measured differentially with respect to a reference cell. This cell is selected by means of a switching element (usually a transistor), which implies that in this case one transistor is required per cell. Besides sensors with one transistor per cell, alternatively sensors without transistors within the cell are considered. The zero-transistor per cell sensor elements in cross-point geometry provide a higher density, but have a somewhat longer read time.

Figure 7 shows a read/write element in write mode. The read-write element has the same components as the sensor element in read mode described above with reference to Figure 6, and in addition a write line 71 for conducting a relatively large write current for generating a first write field component 72. Via bit line 61 a second write current 73 is guided for generating a second write field component 74. The combined field generated by both write currents is strong enough to set the magnetic state in the bit location opposite the read/write element. Writing a certain bit location is equivalent to setting a magnetization in the desired direction, for example, magnetization to the left means '0' and magnetization to the right means '1'. By applying a current pulse to a bit line and a word line a magnetic field pulse is induced. Only the bit location of the information plane opposite the crossing point of both lines experiences the maximum magnetic field (i.e. the vectorial addition of the fields induced by both current pulses) and its magnetization is reversed; all other bit locations above the bit or word line are exposed to the lower field that is caused by a single current pulse and will therefore not change their magnetization directions.

The storage system according to the invention is in particular suitable for the following applications. A first application is a portable device that needs removable memory, e.g. a laptop computer or portable music player. The storage device has low power consumption, and instant access to the data. The record carrier can also be used as a storage medium for content distribution. A further application is a memory that is copyright-protected. In contrast to existing solutions it has all the following properties: easily

replicable, copy-protected, instant-on, fast access time, robust, no moving parts, low power consumption.

Although the invention has been mainly explained by embodiments using the TMR effect, any suitable read/write element for cooperating with the magnetic material can be used, e.g. based on coils. It is noted, that in this document the verb 'comprise' and its conjugations do not exclude the presence of other elements or steps than those listed and the word 'a' or 'an' preceding an element does not exclude the presence of a plurality of such elements, that any reference signs do not limit the scope of the claims, that the invention may be implemented by means of both hardware and software, and that several 'means' or 'units' may be represented by the same item of hardware or software. Further, the scope of the invention is not limited to the embodiments, and the invention lies in each and every novel feature or combination of features described above.

CLAIMS:

1. Storage system comprising a record carrier and a storage device,
- the record carrier having an information plane that is provided with an electro-magnetic material constituting an array of bit locations, a magnetic state of said material at a bit location representing the value thereof,
and
- the storage device having an interface surface for cooperating with the information plane, which interface surface is provided with an array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material,
which record carrier can be coupled to and removed from the storage device, and
- the system having alignment means for positioning the bit locations near the electro-magnetic elements within a near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling.

2. Record carrier for use in the system as claimed in claim 1, the record carrier comprising an information plane on a substrate that is provided with a layer of an electro-magnetic material constituting an array of bit locations, a magnetic state of said material at a bit location representing the value thereof,
characterized in that the record carrier comprises alignment means for positioning the bit locations (23) near the electro-magnetic elements within a near-field working distance between a bit location and the corresponding electro-magnetic element during said coupling.

3. Record carrier as claimed in claim 2, wherein the substrate is of a flexible material for allowing positioning of the bit locations near the electro-magnetic elements within the near-field working distance between a bit location and the corresponding electro-magnetic element.

4. Record carrier as claimed in claim 2, wherein the record carrier comprises a cartridge having an opening for exposing the information plane when coupled to the device and a cover for closing the opening when removed from the device.

5. Record carrier as claimed in claim 4, wherein the cartridge comprises cleaning means for cleaning the information plane and/or the interface surface.

6. Record carrier as claimed in claim 2, wherein the alignment means comprise mechanical guiding elements for cooperating with complementary mechanical receiving elements of the storage device.

7. Storage device for use in the system as claimed in claim 1, characterized in that the device comprises
- an interface surface for cooperating with the information plane, which interface surface is provided with an array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material, and
- alignment means for positioning the electro-magnetic elements near the bit locations within a near-field working distance between an electro-magnetic element and the corresponding bit location during said coupling.

8. Device as claimed in claim 7, wherein the alignment means comprise an actuator for positioning the electro-magnetic elements and/or the record carrier.

9. Device as claimed in claim 8, wherein the actuator for positioning the electro-magnetic elements and/or the record carrier is controlled in dependence of a read-out signal from the electro-magnetic elements.

10. Device as claimed in claim 7, wherein the array of electro-magnetic elements has substantially less electro-magnetic elements then the array of bit locations of the record carrier, and the alignment means are arranged for positioning said array or the record carrier at different alignment positions that in combination cover the total number of bit locations.

11. Device as claimed in claim 7, wherein the alignment means comprise mechanical receiving elements for cooperating with complementary mechanical guiding elements of the record carrier.

12. Device as claimed in claim 7, wherein the alignment means comprise means for generating an attracting field for attracting the record carrier, in particular an electrostatic field.

ABSTRACT:

A record carrier (40) of a removable type has an information plane of a layer of magnetic material on a substrate constituting an array of bit locations (11). A magnetic state of the material represents the value of each bit location. A storage device (35) has an interface surface (32) for cooperating with the information plane. The interface surface has an array (31) of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material. The record carrier and device have alignment elements (38, 41) for positioning the bit locations near the electro-magnetic elements within a near-field working distance between a bit location and the corresponding electro-magnetic element when the record carrier is mounted in the device.

Figure 4a

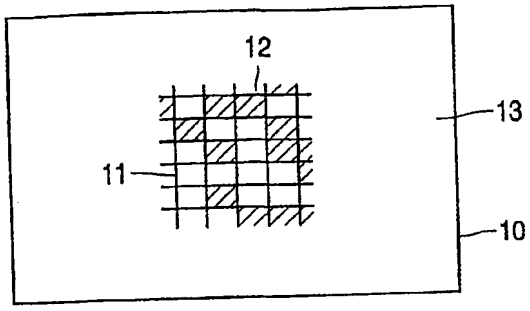


FIG. 1

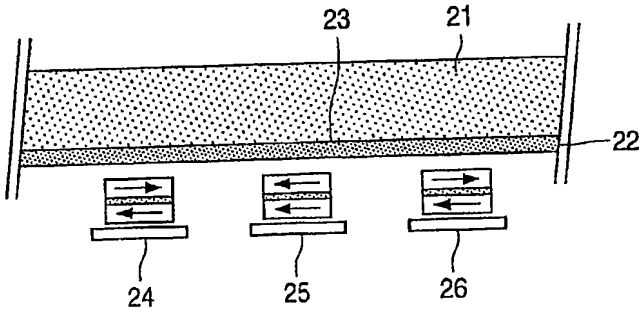


FIG. 2

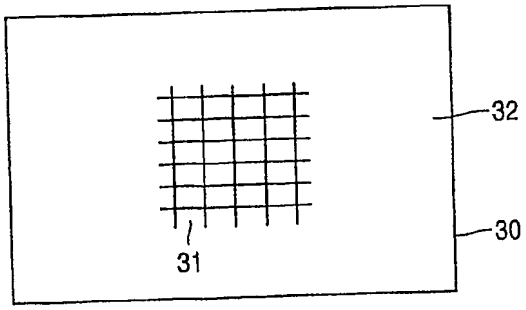


FIG. 3

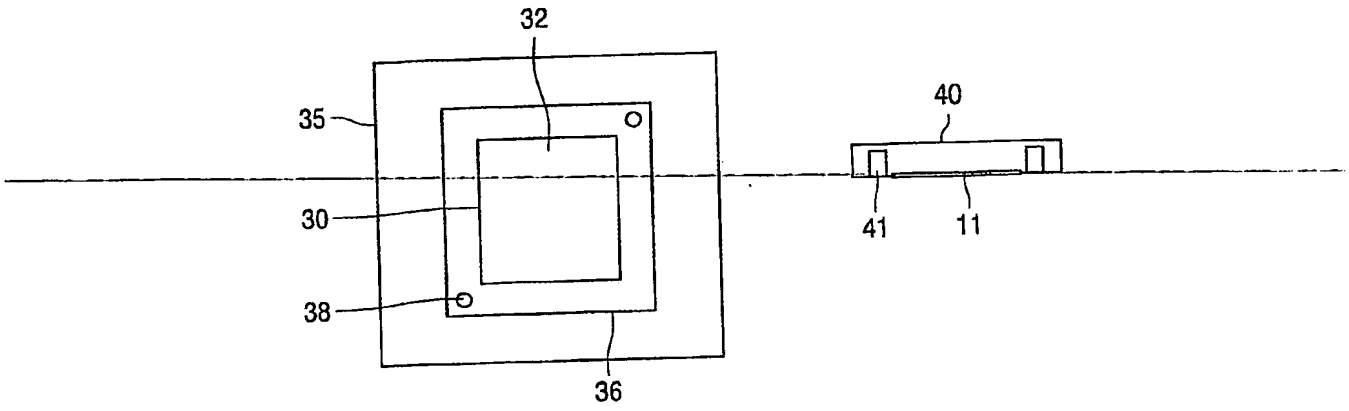


FIG. 4A

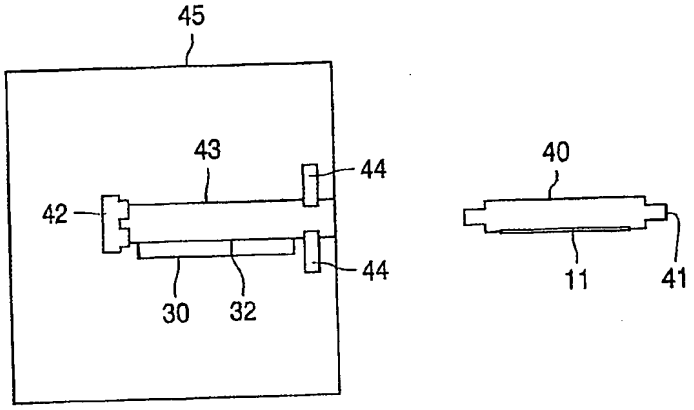


FIG. 4B

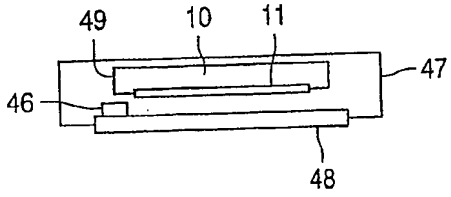


FIG. 4C

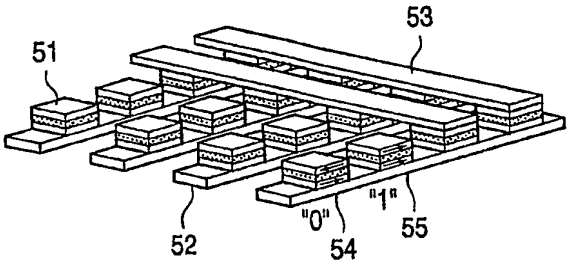


FIG. 5

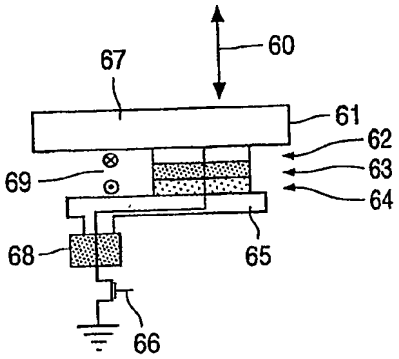


FIG. 6

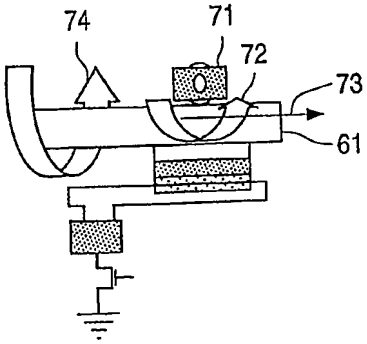


FIG. 7

INTERNATIONAL SEARCH REPORT

International cation No
PCT/IB 03/04007

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G11B5/00 G11B5/48 G11B5/49 G11B5/74 G11C11/15
G11C11/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G11B G11C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 592 413 A (SPITZER RICHARD) 7 January 1997 (1997-01-07) column 6, line 61 -column 7, line 2; figures 1,2 column 9, line 26 -column 9, line 37 column 10, line 14 -column 10, line 37 abstract ---	1-3,7,8
X	EP 1 130 578 A (IBM) 5 September 2001 (2001-09-05) abstract column 5, line 29 -column 5, line 40 column 6, line 19 -column 7, line 15 column 9, line 18 -column 9, line 24 --- -/--	1,2,7,8, 11

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 January 2004	03/02/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lehnberg, C

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Internationa cation No
PCT/IB 03/04007

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 636 893 A (MCCLURE RICHARD J) 13 January 1987 (1987-01-13) column 2, line 13 -column 2, line 44 abstract	1,2,7
A	US 5 956 216 A (CHOU STEPHEN Y) 21 September 1999 (1999-09-21) cited in the application abstract	1,2,7

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB 03/04007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5592413 A	07-01-1997	US 5491338 A	13-02-1996
		US 5237529 A	17-08-1993
		EP 0569547 A1	18-11-1993
		JP 6508954 T	06-10-1994
		WO 9214250 A1	20-08-1992
EP 1130578 A	05-09-2001	EP 1130578 A2	05-09-2001
		JP 2001273601 A	05-10-2001
		US 2001019461 A1	06-09-2001
US 4636893 A	13-01-1987	NONE	
US 5956216 A	21-09-1999	US 5820769 A	13-10-1998

To the European Patent Office

Entry into the European phase (EPO as designated or elected Office)

European application number	
PCT application number	PCT/IB2003/04007
PCT publication number	WO04032115
Applicant's or representative's reference	PHNL020918EP

1. Applicant

Particulars of the applicant(s) are contained in the international publication or were recorded by the International Bureau subsequent to the international publication. ☑

Changes which have not yet been recorded by the International Bureau are set out here: ☐

Address for correspondence

2. Representative 1

This is the representative who will be listed in the Register of European Patents and to whom notifications will be made

Name CHAFFRAIX, Mr Jean

Address of place of business

Société Civile SPID
156 Bd Haussmann
F-75008 PARIS
France

Telephone + 33 01 40 76 80 30

Fax + 33 01 45 61 05 36

e-mail

Any additional representative(s) is/are listed here: ☐

3. Authorisation

An individual authorisation is attached. ☐

A general authorisation has been registered under No: ☐

A general authorisation has been filed, but not yet registered. ☐

The authorisation filed with the EPO as PCT receiving Office expressly includes the European phase. ☐

4. Request for examination

Examination of the application under Art. 94 EPC is hereby requested. The examination fee is being (has been, will be) paid. ☑

Request for examination in an admissible non-EPO language: ☑

Verzocht wordt om onderzoek van de aanvrage als bedoeld in Art. 94.

5. Copies

One or more additional sets of copies of the documents cited in the supplementary European search report are hereby requested. ☐

Number of additional sets of copies

6. Documents intended for proceedings before the EPO

6.1 Proceedings before the EPO as designated Office (PCT I) are to be based on the following documents:

the application documents published by the International Bureau (with all claims, description and drawings), where applicable with amended claims under Art. 19 PCT ☑

unless replaced by the amendments attached. ☐

Where necessary, clarifications should be attached as 'Other Documents'

6.2 Proceedings before the EPO as elected Office (PCT II) are to be based on the following documents:

the documents on which the international preliminary examination report is based, including any annexes ☑

unless replaced by the amendments attached. ☐

Where necessary, clarifications should be attached as 'Other Documents'

If the EPO as International Preliminary Examining Authority has been supplied with test reports, these may be used as the basis of proceedings before the EPO. ☑

7. Translations

Translations in one of the official languages of the EPO (English, French, German) are attached as crossed below:

- *In proceedings before the EPO as designated or elected Office (PCT I + II):*

Translation of the international application (description, claims, any text in the drawings) as originally filed, of the abstract as published and of any indication under Rule 13bis.3 and 13bis.4 PCT regarding biological material ☐

Translation of priority application(s) ☐

It is hereby declared that the international application as originally filed is a complete translation of the previous application (Rule 38(5) EPC) ☐

- *In addition, in proceedings before the EPO as designated Office (PCT I):*

Translation of amended claims and any statement under Art. 19 PCT, if the claims as amended are to form the basis for the proceedings before the EPO (see Section 6). ☐

- *In addition, in proceedings before the EPO as elected office (PCT II):*

Translation of annexes to the international preliminary examination report ☐

8. Biological material

The invention relates to and/or uses biological material deposited under Rule 28 EPC. ☐

The particulars referred to in Rule 28(1)(c) EPC (if not yet known, the depository institution and the identification reference(s) [number, symbols, etc.] of the depositor) are given in the international publication or in the translation submitted under Section 7 on: ☐

page(s) / line(s)

A copy of the receipt(s) of deposit issued by the depositary institution

is attached ☐

will be filed at a later date ☐

A waiver of the right to an undertaking from the requester pursuant to Rule 28(3) EPC is attached. ☐

9. Nucleotide and amino acid sequences

The items required under Rules 5.2 and 13ter PCT and Rule 111(3) EPC have already been furnished to the EPO. ☐

The sequence listing as part of the description is attached in PDF format. ☐

The sequence listing does not include matter that goes beyond the content of the application as filed. ☐

In addition, the sequence listing data is attached in computer-readable form in accordance with WIPO Standard 25. ☐

The sequence listing data in computer-readable form in accordance with WIPO Standard 25 is identical to the sequence listing in PDF format. ☐

10. Designation fees

10.1 It is currently intended to pay seven times the amount of the designation fee. The designation fees for all the EPC contracting states designated in the international application are thereby deemed to have been paid (Art. 2 No. 3 RFees). ☑

AT BE BG CH&LI CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LT LU MC NL PL PT RO SE SI SK TR

10.2 The declaration in No. 10.1 does not apply. Instead, it is currently intended to pay fewer than seven designation fees for the following EPC contracting states designated in the international application: ☐

It is requested that no communications under Rule 108(3) EPC be issued in respect of any contracting states not indicated.

10.3 If an automatic debit order has been issued (Section 12), the EPO is authorised, on expiry of the basic period under Rule 107(1)(d) EPC, to debit seven times the amount of the designation fee. If states are indicated in No. 10.2, the EPO will debit designation fees for those states only, unless instructed otherwise before the basic period expires. ☑

11. Extension of the European patent

This application is also considered as being a request for extension to all the non-contracting states to the EPC designated in the international application with which "extension agreements" were in force on the date of filing the international application. However, the extension only takes effect if the prescribed extension fee is paid. ☑

It is currently intended to pay the extension fee for the following states:

12. Automatic debit order ☑

Currency: EUR

The EPO is hereby authorised, under the Arrangements for the automatic debiting procedure, to debit from the deposit account below any fees and costs falling due. For designation fees, see "States".The EPO is also authorised, on expiry of the basic period for paying the extension fees, to debit those fees for each of the "extension states" indicated in "States",

Deposit account number: 28090021
Account holder: PHILIPS INTERNATIONAL B.V. - IP&S

13. Reimbursements (if any) should be made to the following EPO deposit account: ☑

Number and account holder: 28090021, PHILIPS INTERNATIONAL B.V. - IP&S

14. Fees

		Factor applied	Fee schedule	Amount to be paid
14-1	002 Search fee	0	690.00	0.00
14-2	015 Claims fee	2	40.00	80.00
14-3	020 Basic national fee for an international application	1	90.00	90.00
14-4	033 Renewal fee for the 3rd year	1	380.00	380.00
	Total:		**EUR**	**550.00**

15. Annotations

16. Signature(s) of applicant(s) or representative

Place: **PARIS**
Date: **15 March 2005**
Signed by: **Subject: FR, Société Civile S.P.I.D., J. Chaffraix 1193**
Issuer: , European Patent Office, European Patent Office CA
Capacity: **(Déposant)**

For employees (Art. 133(3) EPC) having a general authorisation:
General authorisation No.

Europäisches Patentamt | European Patent Office | Office européen des brevets

Acknowledgement of receipt

We hereby acknowledge receipt of the form for entry into the European phase (EPO as designated or elected Office) as follows:

Submission number	43472	
PCT application number	PCT/IB03/04007	
Date of receipt	15 March 2005	
Your reference	PHNL020918EP	
Applicant		
Country		
Documents submitted	EPF1200.PDF ep-euro-pct.xml	application-body.xml package-data.xml
Submitted by	CN=J. Chaffraix 1193,O=Société Civile S.P.I.D.,C=FR	
Method of submission	Online	
Date and time receipt generated	15 March 2005, 15:41:45	
Digest	2E:48:50:63:D8:33:94:02:B9:46:FF:1F:0E:BB:28:C1:12:F9:7B:7A	

/European Patent Office/

SPID

Paris, 07 Juin 2005.

OREF : GBA/ML
PHNL020918EP

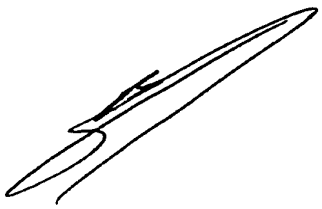
YREF : OFFICE EUROPEEN DES BREVETS
Directorate General 2
Erhardtstrasse 27
D-80298 MUNCHEN

- ALLEMAGNE -

Objet: Amendment of application documents (Rule 109 EPC)
Demande n° 03798985.2 – 2210 – PCT/IB0304007

The applicant requests that the following pages of the application as filed are replaced :
- pages 13, 14 and 15 by pages 13, 14 and 15 attached to this letter.

Le Mandataire,
G. BAQUE.



Attached documents :
- New set of claims
- New claims 1, 2 and 7 with apparent modifications.

CLAIMS:

1. Storage system comprising a record carrier and a storage device,

- the record carrier having an information plane that is provided with an electro-magnetic material constituting a two-dimensional array of bit locations, a magnetic state of said material at a bit location representing the value thereof,

and

- the storage device having an interface surface for cooperating with the information plane, which interface surface is provided with a two-dimensional array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material,

which record carrier can be coupled to and removed from the storage device, and

- the record carrier and the storage device having complementary alignment elements for mechanically cooperating during said coupling for positioning the bit locations in at least one aligned position with respect to the two-dimensional array of ~~the~~ electro-magnetic elements, within a near-field working distance between a bit location and the corresponding electro-magnetic element.

2. Record carrier for use in the system as claimed in claim 1, the record carrier comprising an information plane on a substrate that is provided with a layer of an electro-magnetic material constituting a two-dimensional array of bit locations, a magnetic state of said material at a bit location representing the value thereof,
characterized in that the record carrier comprises alignment elements for mechanically cooperating during said coupling with complementary alignment elements of the storage device for positioning the two-dimensional array of bit locations in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements, within a near-field working distance between a bit location and the corresponding electro-magnetic element.

3. Record carrier as claimed in claim 2, wherein the substrate (21) is of a flexible material for allowing positioning of the bit locations near the electro-magnetic elements

within the near-field working distance between a bit location and the corresponding electro-magnetic element.

4. Record carrier as claimed in claim 2, wherein the record carrier comprises a cartridge (47) having an opening for exposing the information plane when coupled to the device and a cover (48) for closing the opening when removed from the device.

5. Record carrier as claimed in claim 4, wherein the cartridge comprises cleaning means (46) for cleaning the information plane and/or the interface surface.

6. Record carrier as claimed in claim 2, wherein the alignment means (41) comprise mechanical guiding elements for cooperating with complementary mechanical receiving elements of the storage device.

7. Storage device for use in the system as claimed in claim 1, characterized in that the device comprises:

- an interface surface for cooperating with the information plane, which interface surface is provided with a two-dimensional array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material, and
- alignment means comprising alignment elements for mechanically cooperating during said coupling with complementary alignment elements of the record carrier for positioning the two-dimensional array of electro-magnetic element in at least one aligned position with respect to the two-dimensional array of bit location, within a near-field working distance between an electro-magnetic element and the corresponding bit location.

8. Device as claimed in claim 7, wherein the alignment means (42,44) comprise an actuator for positioning the electro-magnetic elements and/or the record carrier.

9. Device as claimed in claim 8, wherein the actuator for positioning the electro-magnetic elements and/or the record carrier is controlled in dependence of a read-out signal from the electro-magnetic elements.

10. Device as claimed in claim 7, wherein the array of electro-magnetic elements (31) has substantially less electro-magnetic elements then the array (11) of bit locations of the

record carrier, and the alignment means (42,44) are arranged for positioning said array or the record carrier at different alignment positions that in combination cover the total number of bit locations.

11. Device as claimed in claim 7, wherein the alignment means (38) comprise mechanical receiving elements for cooperating with complementary mechanical guiding elements (41) of the record carrier.

12. Device as claimed in claim 7, wherein the alignment means comprise means for generating an attracting field for attracting the record carrier, in particular an electrostatic field.

Amended claims:

1. Storage system comprising a record carrier and a storage device,
- the record carrier having an information plane that is provided with an electro-magnetic material constituting a **two-dimensional** array of bit locations, a magnetic state of said material at a bit location representing the value thereof,
and
- the storage device having an interface surface for cooperating with the information plane, which interface surface is provided with a **two-dimensional** array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material,
which record carrier can be coupled to and removed from the storage device, and
- the ~~system~~ **record carrier and the storage device** having **complementary** alignment **elements for mechanically cooperating during said coupling** ~~means~~ for positioning the bit locations ~~near~~ **in at least one aligned position with respect to the two-dimensional array of** ~~the~~ electro-magnetic elements, within a near-field working distance between a bit location and the corresponding electro-magnetic element ~~during said coupling~~.

2. Record carrier for use in the system as claimed in claim 1, the record carrier comprising an information plane on a substrate that is provided with a layer of an electro-magnetic material constituting a **two-dimensional** array of bit locations, a magnetic state of said material at a bit location representing the value thereof,
characterized in that the record carrier comprises **alignment elements for mechanically cooperating during said coupling with complementary alignment elements of the storage device** for positioning the **two-dimensional array of** bit locations ~~near the~~ **in at least one aligned position with respect to the two-dimensional array of** electro-magnetic elements, within a near-field working distance between a bit location and the corresponding electro-magnetic element ~~during said coupling~~.

7. Storage device for use in the system as claimed in claim 1, characterized in that the device comprises

- an interface surface for cooperating with the information plane, which interface surface is provided with a **two-dimensional** array of electro-magnetic elements that are sensitive to said magnetic state of the electro-magnetic material, and
- alignment means **comprising alignment elements for mechanically cooperating during said coupling with complementary alignment elements of the record carrier** for positioning the **two-dimensional array of** electro-magnetic element ~~and the corresponding~~ **in at least one aligned position with respect to the two-dimensional array of** bit location, within a near-field working distance between an electro-magnetic element and the corresponding bit location ~~during said coupling~~.

SPID

Paris, 17/11/2005

N/REF PHNL020918
BR/05/196
V/REF

EPO - Munich
21
24. Nov. 2005

OFFICE EUROPEEN DES BREVETS
Direction Générale 2
Erhardtstrasse 27
D - 80298 MUNCHEN - ALLEMAGNE

A l'attention de l' Examinateur
pour la Division d'Examen

OBJET : Requête en prorogation de délai
Demande de Brevet N° 03798985.2
Votre Réf. : Notification du : 02/11/2005

Je, soussigné, demande une prorogation de délai de 2 mois en vertu de la Règle 84 du Réglement d'Exécution de la Convention sur le Brevet européen.

Motif : l'élaboration de la réponse à la notification nécessite des consultations au sein des sociétés demanderesses qui ne seraient pas achevées dans un délai de 4 mois.

M. Grégory BAQUE
Le Mandataire

PROPRIETE INDUSTRIELLE
SOCIETE CIVILE "SPID" 156 Boulevard HAUSSMANN 75008 PARIS (FRANCE)
Tél. : 33 (0)1 40 76 80 00 Fax : 33 (0)1 45 61 05 36 Liste Spéciale INPI 422-5/S008

SPID

Paris, 23.02.06.

OREF : GBA/ML
PHNL020918 EP (PCT)

YREF : EUROPEAN PATENT OFFICE
Directorate General 2
Erhardtstrasse 27
D-80298 MUNCHEN

- ALLEMAGNE -

For the attention of Mr. C. LEHNBERG
Primary Examiner for the Examining Division

Object: Response to notification dated 02.11.05
Application No 03 798 985.2-2210

Sir,
Please find hereinafter our answer to the communication mentioned above.

All references are made with respect to the text published as PCT/IB04/04007.

Please replace pages 13, 14 and 15 by the amended pages 13, 14 and 15.

We propose a new set of claims on the basis of which we request grant of the patent.

Claim amendments

1. The text "...characterized in that..." has been added to claim 1 (filed on June 7th 2005) before the text "...the record carrier and the storage device having complementary...".

2. The text "...characterized in that the storage device comprises..." has been added in claim 7 (filed on June 7th 2005) before the text "alignment means comprising alignment elements...".

3. Reference numbers have been added.

Novelty of amended claim 1

Amended claim 1 discloses a storage system comprising a record carrier and a storage device. The record carrier can be coupled to and removed from the storage device and comprises electromagnetic material that constitutes a two dimensional array of bit locations. A magnetic state of said material represents the value thereof. The storage device has a two dimensional array of electromagnetic sensor elements that are sensitive to the magnetic state of the electromagnetic material. The record carrier and the storage device comprise complementary alignment elements for mechanically cooperating during said coupling for positioning the bit locations in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements.

* EP 1 103 578 A2 (D2) Prior art embodiment : the prior art in D2 discloses Atomic Force Microscope thermo-mechanical recording in polymer storage media. Thermo-mechanical writing is a combination of applying a local force by a cantilever/tip to the polymer layer and softening it by local heating. By applying sufficient heat, an indentation can be formed into the storage medium for writing a bit which can be read back with the same tip. The bit-writing process in the prior art embodiment of D2 is coupled to a structural mechanical change in the medium which appears in the medium surface which is subject to mechanical wear.

The amended claim 1 is novel over the embodiment cited as the prior art of D2 in that the prior art embodiment of D2 does not disclose a magnetic recording system, but discloses bit-writing which creates indentations in the storage medium. Furthermore the prior art embodiment of D2 as discussed in D2 does not disclose an array of cantilever/tips and does not disclose means or a method of aligning the cantilever/tip to the indentations.

* EP 1 103 578 A2 (D2) : the objective of the invention disclosed in document D2 with respect to the prior art embodiment of D2 (see above), is to provide a storage system which does not suffer from mechanical wear. The mechanical wear is defined on the one hand as being a mechanical wear of the writing tip which must create the indentations and on the other hand as being a mechanical wear of the sensing tip for sensing the indentations. In a further embodiment as disclosed in D2 the storage system has magnetic storage bits. The bit writing is achieved by applying heat very locally in bit size dimensions in order to let the (temperature-dependent) coercive field at the location where heat is applied become locally smaller than an external magnetic field. The applied heat results in a so called compensation temperature, which "...is at a temperature best suited for the writing process, or such that the temperature at which the materials loose their ferromagnetism, i.e., the Curie temperature, is not too far above the writing temperature..." [column 4, lines 32 to 35]. A two-dimensional array of cantilever tips is used in the storage system, each of which tips serves as a heat source and for reading the field. Bits can be generated with or without direct contact between tip and storage medium. No disclosure on the positioning of the array of cantilever tips to the array of storage bits.

The amended claim 1 is novel over the embodiment having magnetic storage bits as disclosed in D2, because this embodiment does not disclose complementary alignment elements between the record carrier and the storage device for mechanically cooperating

during the coupling for positioning the bit locations in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements.

Inventiveness of the amended claim 1

Document D2 is considered closest prior art with respect to the amended claim 1, because D2 discloses an embodiment comprising an array of magnetic bit locations being statically read by an array of sensors (cantilever/tips).

An objective problem of document D2 is that when loading the storage medium into the storage device, the array of sensors must be aligned with respect to the array of magnetic bits in a low-cost environment.

A solution to the objective problem is obtained by the amended claim 1, in which "...the record carrier and the storage device have complementary alignment elements for mechanically cooperating during said coupling for positioning the bit locations in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements, within a near-field working distance between a bit location and the corresponding electro-magnetic element."

Although document D2 does not disclose specific alignment means between the array of sensors and the array of magnetic bits, D2 discloses Atomic Force Microscope devices which typically comprise expensive positioning systems. The positioning system is arranged for moving and positioning the cantilever tip accurately with respect to a structure which must be measured. Typically expensive servo motors and interferometer positioning sensors are applied. D2 does not disclose specific means for aligning the array of bit locations to the array of cantilever/tips and clearly does not disclose a low-cost solution for aligning the array of sensors with respect to the array of magnetic bits. Therefore, the skilled person would not find a solution to the objective problem in D2.

* Document D1 (US-A-5,592,413) discloses the presence of alignment means in the system, e.g. column 9, lines 35-37: "although in some embodiments the invention may allow for limited motion for alignment or positioning over blocks of data prior to data transfer". However D1 does not disclose that the alignment is performed during coupling of the storage medium to the array of transducers. More specifically, D1 does not disclose that both the storage medium and the storage device comprise complementary mechanical alignment means.

* Document D3 (US-A-4,636,893) discloses a planar array of magnetic head scanning a medium. The "...recording and playback of the stored information occurs coincidentally with the movement of the head array relative to the medium..." [Column 2, lines 29-31]. Alignment in systems in which a storage medium moves relative to the sensor when reading information is typically very different from alignment in systems where the storage medium

remains static relative to the sensor when reading information. The skilled person searching for alignment solutions between an array of bit locations and an array of sensor elements which do not move during the reading of information will not consult a document in which the recording and playback of information occurs while the array of sensor elements are moving with respect to the array of bit locations.

* Document D4 (US-A-5,956,216) also discloses a storage system and a record carrier in which the information from the record carrier is retrieved while the record carrier moves relative to the storage system. Again, the skilled person searching for alignment solutions between an array of bit locations and an array of sensor elements which do not move during the reading of information will not consult a document in which the recording and playback of information occurs while the array of sensor elements are moving with respect to the array of bit locations.

In view of the reasoning above, the amended claim 1 is inventive over the cited prior art documents D1, D2, D3 and D4.

With respect to the remaining comments of the examiner

The examiner states that "...the self-alignment provided in D2 (see column 5, paragraph 32) between the tips and the bit locations is considered to be a mechanical alignment means...". However, the self-alignment indicated at the cited position in D2 discloses the alignment of individual bits in the array of bits with respect to individual tips in the array of tips. This is different from the alignment claimed in the amended claim 1, in which the alignment results in positioning the total array of bit locations with respect to the total array of electro-magnetic elements. Also D2 indicates that in some embodiments the array of bits is aligned to the array of tips. See, for example column 8 paragraph 53 and 54. However, D2 fails to disclose how the array of bits is aligned to the array of tips in the embodiment where the array of tips must be moved to a different position.

The examiner states that "...once the bit is written, an indentation is formed which is retrieved by the read back tip of the head array during the read operation (column 2, paragraph 6). The indentations and the read back tips are considered to be complementary alignment elements for mechanically cooperating during the coupling..." [letter of examiner dated November 2nd 2005]. However, the text cited by the examiner from D2 refers to the prior art embodiment of D2 (described in column 2, paragraph 6) and not to the embodiment having magnetic storage bits of D2. According to the guidelines for examination "It is also not permissible to combine separate items belonging to different embodiments described in one and the same document, unless such combination has specifically been suggested (T 305/87, OJ 8/1991, 429)" (Guidelines, part C, chapter IV, paragraph 7.1). Because one embodiment is discussed as prior art and the further embodiment having magnetic storage bits is an embodiment according to the invention of D2, the features of these two embodiments should not be combined.

In the prior art embodiment of D2 only a single tip is used for writing indentations and thus for writing bits into the medium. Furthermore, the purpose of the indentations in the prior art embodiment of D2 is also clearly described in document D2 as representing the content of the bits and therefore cannot be used for alignment purposes.

In the embodiment having magnetic storage bits of D2, the array of bits does not contain indentations. This can clearly and unambiguously be concluded by the skilled person when consulting the text of D2. In addition, document D2 teaches away from the prior art embodiment in that D2 has as its objective to provide a storage system which does not suffer from mechanical wear which results from the creation and reading of the indentations as indicated in column 2 paragraph 9.

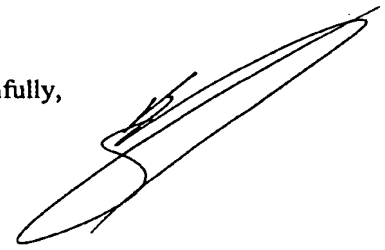
The examiner states that the present claims 1 and 2 are unclear because the material forming the information plate of the record carrier should be "magnetic" material rather than "electro-magnetic" material.

However, the reason for using "electro-magnetic" material rather than "magnetic" material is that in the text on page 5, lines 3 to 10 is indicated that also other material may be chosen. For example, phase-change material known from CD-RW may be used. Replacing "electro-magnetic" material by "magnetic" material would limit the scope of the disclosure unnecessarily and would result in not including this embodiment.

Conclusion

In view of the discussion presented above, the objections with respect to novelty and inventiveness of the claims are believed to be overcome. Nevertheless, in the event refusal of any of the claims is envisaged, oral proceedings pursuant Article 116 EPC are herewith requested.

Yours faithfully,



The Professional Representative,
Grégory BAQUE.

Enclosed Annexe :

- New set of claims

Claims:

1. Storage system comprising a record carrier (40) and a storage device (35),
- the record carrier (40) having an information plane that is provided with an electro-magnetic material constituting a two-dimensional array of bit locations (11), a magnetic state of said material at a bit location representing the value thereof, and
- the storage device (35) having an interface surface (32) for cooperating with the information plane, which interface surface (32) is provided with a two-dimensional array of electro-magnetic elements (24, 25, 26) that are sensitive to said magnetic state of the electro-magnetic material,
which record carrier (40) can be coupled to and removed from the storage device (35),
characterized in that the record carrier (40) and the storage device (35) have complementary alignment elements (38, 41) for mechanically cooperating during said coupling for positioning the bit locations (11) in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements (24, 25, 26), within a near-field working distance between a bit location and the corresponding electro-magnetic element.

2. Record carrier (40) for use in the system as claimed in claim 1, the record carrier (40) comprising an information plane on a substrate (21) that is provided with a layer (22) of an electro-magnetic material constituting a two-dimensional array of bit locations (11), a magnetic state of said material at a bit location representing the value thereof,
characterized in that the record carrier (40) comprises alignment elements (41) for mechanically cooperating during said coupling with complementary alignment elements (38) of the storage device (35) for positioning the two-dimensional array of bit locations (11) in at least one aligned position with respect to the two-dimensional array of electro-magnetic elements (24, 25, 26), within a near-field working distance between a bit location and the corresponding electro-magnetic element.

3. Record carrier (40) as claimed in claim 2, wherein the substrate (21) is of a flexible material for allowing positioning of the bit locations (11) near the electro-magnetic elements (24, 25, 26) within the near-field working distance between a bit location and the corresponding electro-magnetic element.

4. Record carrier (40) as claimed in claim 2, wherein the record carrier (40) comprises a cartridge (47) having an opening for exposing the information plane when coupled to the device and a cover (48) for closing the opening when removed from the device.

5. Record carrier (40) as claimed in claim 4, wherein the cartridge (47) comprises cleaning means (46) for cleaning the information plane and/or the interface surface (32).

6. Record carrier (40) as claimed in claim 2, wherein the alignment means (41) comprise mechanical guiding elements for cooperating with complementary mechanical receiving elements of the storage device (35).

7. Storage device (35) for use in the system as claimed in claim 1, characterized in that the device comprises
- an interface surface (32) for cooperating with the information plane, which interface surface (32) is provided with a two-dimensional array of electro-magnetic elements (24, 25, 26) that are sensitive to said magnetic state of the electro-magnetic material, and
characterized in that the storage device (35) comprises alignment means comprising alignment elements (38) for mechanically cooperating during said coupling with complementary alignment elements (41) of the record carrier (40) for positioning the two-dimensional array of electro-magnetic elements (24, 25, 26) in at least one aligned position with respect to the two-dimensional array of bit locations (11), within a near-field working distance between an electro-magnetic element and the corresponding bit location.

8. Device (35) as claimed in claim 7, wherein the alignment means comprise an actuator for positioning the electro-magnetic elements (24, 25, 26) and/or the record carrier (40).

9. Device (35) as claimed in claim 8, wherein the actuator for positioning the electro-magnetic elements (24, 25, 26) and/or the record carrier (40) is controlled in dependence of a read-out signal from the electro-magnetic elements (24, 25, 26).

10. Device (35) as claimed in claim 7, wherein the array of electro-magnetic elements (31) has substantially less electro-magnetic elements then the array (11) of bit

locations of the record carrier (40), and the alignment means (42, 44) are arranged for positioning said array or the record carrier (40) at different alignment positions that in combination cover the total number of bit locations.

11. Device (35) as claimed in claim 7, wherein the alignment means (38) comprise mechanical receiving elements for cooperating with complementary mechanical guiding elements (41) of the record carrier (40).

12. Device (35) as claimed in claim 7, wherein the alignment means comprise means for generating an attracting field for attracting the record carrier (40), in particular an electrostatic field.

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.